



Office of ENERGY EFFICIENCY  
& RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

2020 SETO PEER REVIEW

# Solar Collectors

## Peer Review 2020

---

Andru Prescod, Ph.D.

Technology Development Manager

Contracted to the US Department of Energy

[energy.gov/solar-office](https://energy.gov/solar-office)

# Solar Field remains the most expensive subsystem of the CSP plant

## O&M TARGET

\$40/kW-yr plus \$3/MWh

5¢/kWh

## RECEIVER

Thermal Efficiency  $\geq 90\%$   
Lifetime  $\geq 10,000$  cyc  
Cost  $\leq \$150/\text{kW}_{\text{th}}$   
Exit Temp  $\geq 720^\circ\text{C}$

## SOLAR FIELD

Cost  $\leq \$50/\text{m}^2$   
Lifetime  $\geq 30$  yrs  
Annual Efficiency  $\geq 55\%$   
Concentration Ratio  $\geq 1000$  Suns

## HEAT TRANSFER MEDIUM

Thermally Stable  $\geq 800^\circ\text{C}$   
Compatible with Rec. Performance  
Compatible with TES Performance

## POWER BLOCK

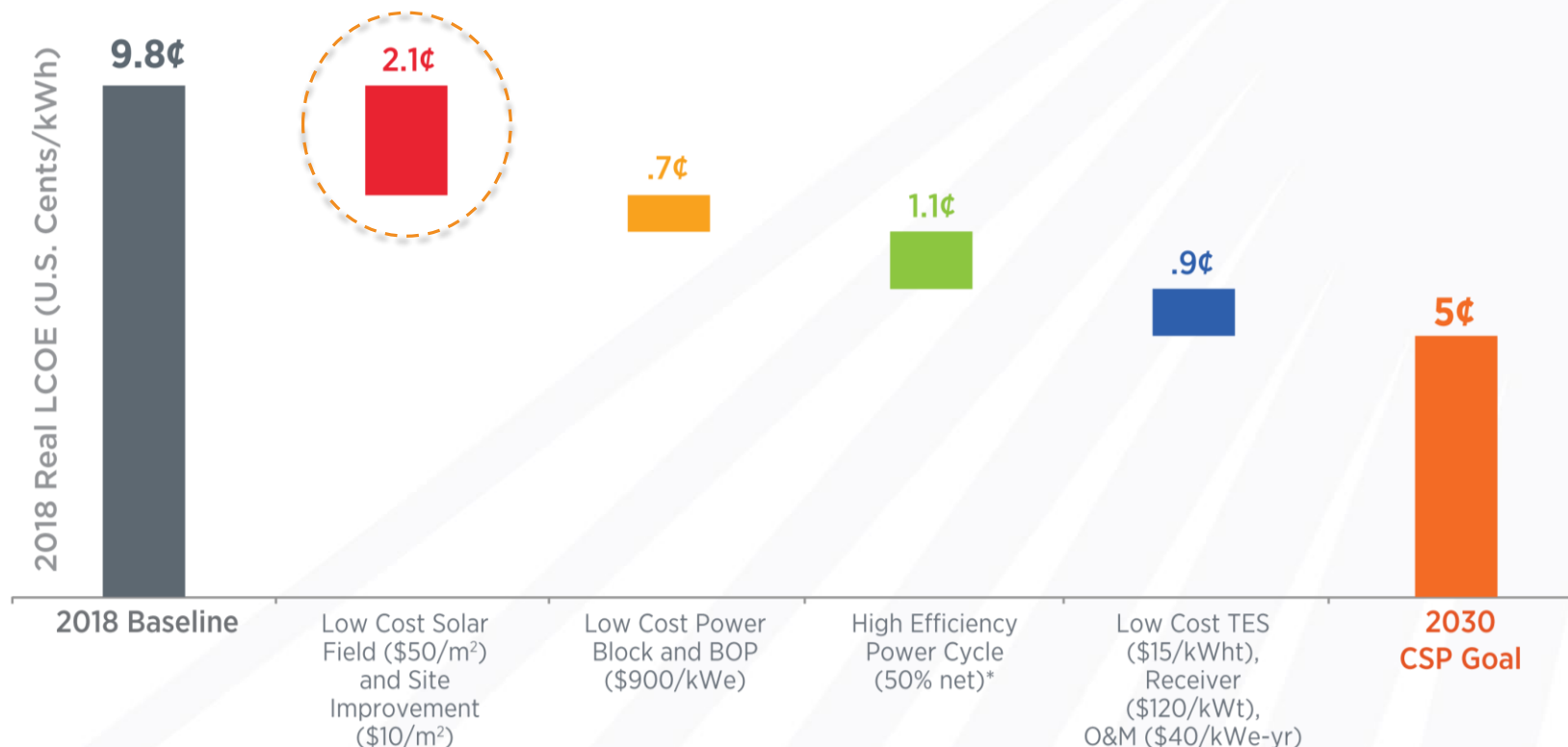
Net Cycle Efficiency  $\geq 50\%$   
Dry Cooled  
Cost  $\leq \$900/\text{kW}_e$

## THERMAL STORAGE

Energy Efficiency  $\geq 99\%$   
Exergetic Efficiency  $\geq 95\%$   
Cost  $\leq \$15/\text{kWh}_{\text{th}}$   
Power Cycle Inlet Temp  $\geq 720^\circ\text{C}$

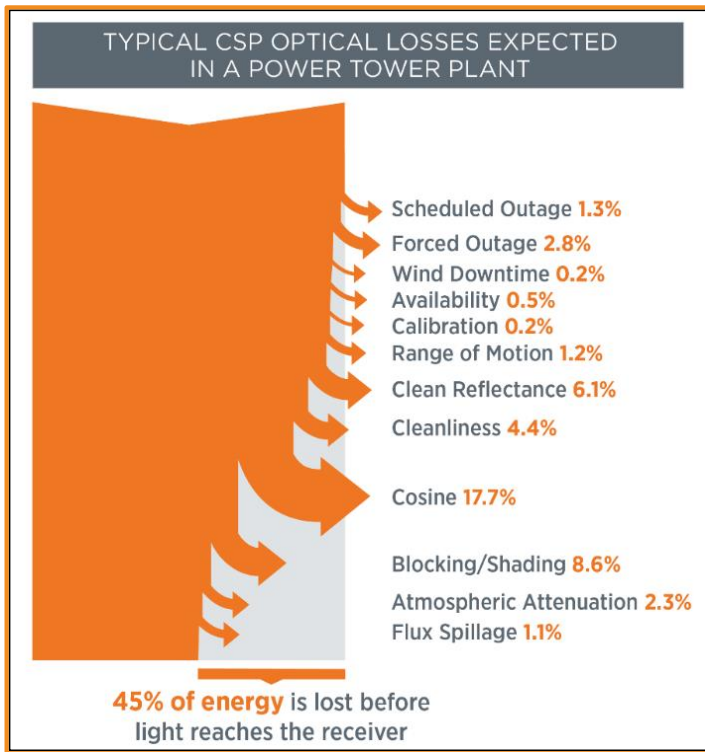
- Heliostat costs are still  $> \$100/\text{m}^2$
- Subcomponent major cost drivers are the support structure, azimuth drive, foundation, reflector and labor
- Cost reduction, while maintaining high efficiency and concentration ratio is challenging and requires a multifaceted approach
- Contribution of solar field costs and other subsystems are required to be low enough to achieve 5 Cents per kWh for Baseload CSP in 2030

# In one projected scenario, to achieve 5 Cents per KWh for a Baseload CSP in 2030, the solar field cost has to be reduced by ~2 cents/kWh



\*Assumes a gross to net conversion factor of 0.9

# And to achieve the 2030 cost solar field cost reduction goal, a suite of strategies and solutions have to be pursued



## Potential Solutions

- Cheaper manufacturing methods and materials
- Autonomous controls and wireless communication
- Optimizing optical performance
- Improving the supply chain
  - Difficult to impact at both R&D and Pilot scales
- Standardization of materials, tools and components

# Our Portfolio includes Next Generation Collectors

## SolarDynamics



### Drop-C Heliostat

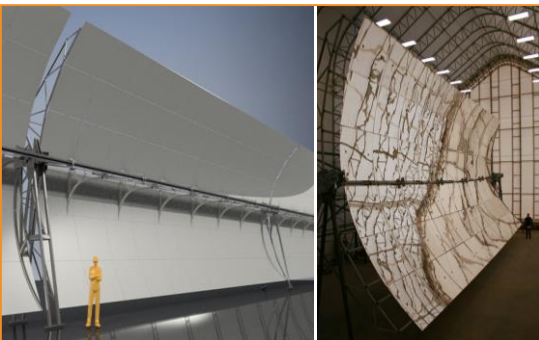
Low cost heliostat with innovative supporting structure to withstand high wind loads. Coupled to a wireless mesh network and capability for rapid calibration and low pointing errors. Validated to be compatible with surround-type receivers.

## SolarDynamics



### Simplified Melting and Rotation-joint Technology (SMART) for Molten Salt Troughs

Improving the cost and reliability of molten salt HTFs at temperatures up to 565C in parabolic trough solar fields, to accelerate the transition to commercial project development through increased bankability. Critical technical challenges such as the freeze-recovery subsystem, the rotation-expansion piping joints, and the need to re-optimize the solar field design based on recent hardware and market evolution are addressed.



### ATLAS Parabolic Trough

Long continuous array to reduce rotary interconnects. Variable drive spacing to reduce moment accumulation. Lighter, simpler frame design enabled by “low-torque” design condition. Novel large-format mirror design enables frame simplification. Non-trenched alternative systems for drive power and tracking control.

# And Novel Collector Designs, some of which overlap with IPH



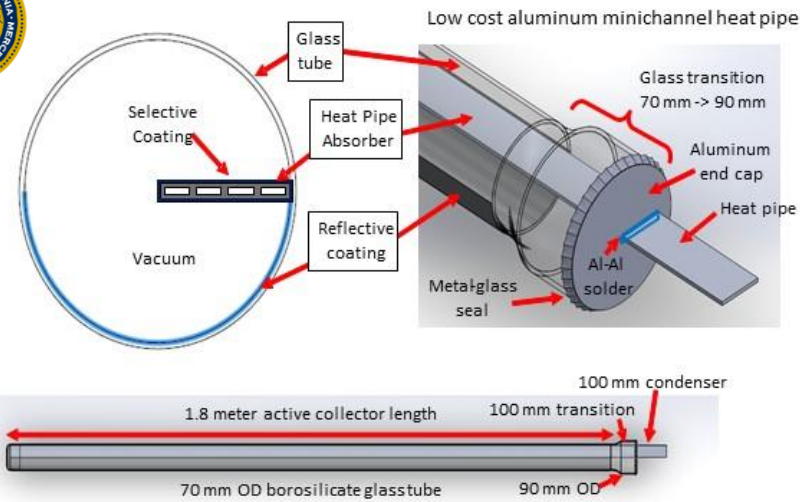
## Green Parabolic Trough Collector

Uses of a special grade of wood as the structural material, and the geometric arrangement of the structural members in a material-efficient typology.



## Low Cost Linear Fresnel Collector

Linear Fresnel CSP collector system, that focuses mirrors using plastic extrusion structures deployed on a sealed waterbed foundation. The architecture uses light-weight, recyclable, 30-year outdoor plastics instead of traditional CSP systems' expensive concrete and steel support structures to focus mirrors on a receiver to produce thermal energy.



## Internal Compound Parabolic Concentrator with low-cost heat pipe and vacuum tube with integrated optics

Flexible (non-tracking) installation, low O&M cost. Provides low-cost, dispatchable heat @ 120 C.



[energy.gov/sunshot](https://energy.gov/sunshot)

# We also have a variety of collector metrology projects

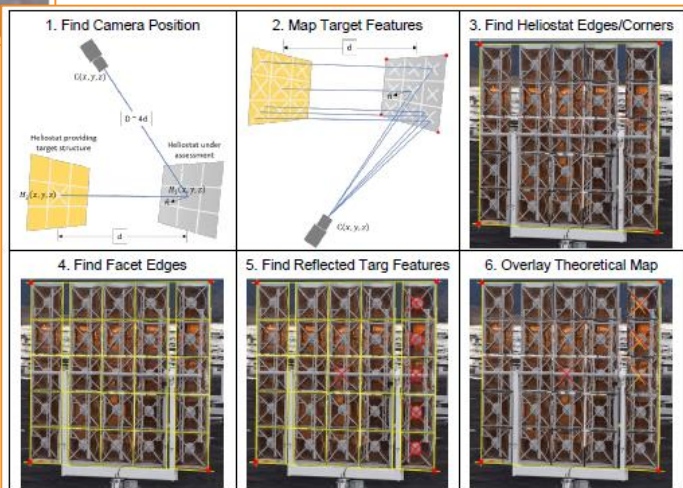
## UFACET/NIO for Heliostats

UAV measurements of slope and canting errors in heliostats. Two approaches, using 1) a target heliostat and 2) the tower to determine errors.



## Direct Observer for Parabolic Troughs (NREL)

Measures slope and receiver alignment errors in Parabolic troughs.



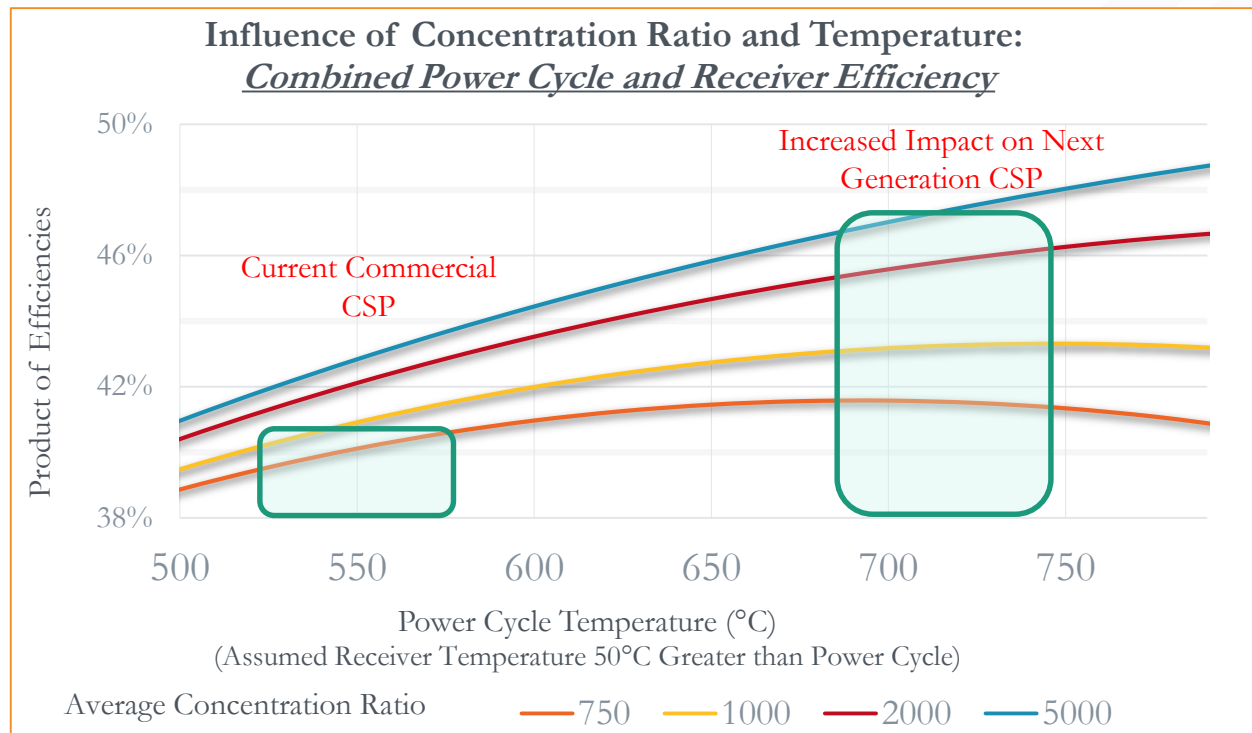
## Lidar Inspection Tool

Uses 3D scanning Light Detecting And Ranging (LiDAR) sensors in the automatic/autonomous assessment of the optical errors in large scale CSP heliostat fields. Demonstrated ability to acquire highly accurate point cloud measurements across several Sandia NSTTF heliostats.



[energy.gov/sunshot](http://energy.gov/sunshot)

## But more opportunities exist as we look towards 2030



- Higher system-level efficiencies can be achieved with increased Average Concentration Ratios and Receiver Temperatures
- Additional opportunities include Reduced Collector Field Deployment time, Novel Reflectors and Low cost, accurate drives

# So what could be next?

## Target identified remaining solar field challenges

### Remaining challenges include:

- US market is currently very limited. Supply chain is not developed
- Information sharing among competitors is minimal. IP is strongly protected
- Current measurement techniques are labor intensive and slow
- Manufacturing methods are not optimized
- Lower cost materials, with long lifetimes are still needed
- Solar field cleaning methods are still not optimized
- Impact of wind loads on solar field varies by site and not completely understood

## Continue to work with industry to address these challenges

### Potential solutions include:

- Dedicated facility for testing manufacturing and testing methodologies
- Dedicated Funding Opportunity
- Upgrade current facilities or build new infrastructure at our National Labs
- Cleaning methods should be designed upfront by collector manufacturer, as opposed to an afterthought
- New lower-cost, durable materials for drives

# Solar Collectors

## Peer Review 2020

---

Andru Prescod, Ph.D.

Technology Development Manager

Contracted to the US Department of Energy